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Reptiles and Batrachians.—G. A. Boulenger gives a list of thirty-one reptiles and sixteen batrachians from the province of Rio Grande do Sul, Brazil, collected by Dr. H. von Ihering. The new species are *Enyalius iheringii*, and *Liolaemus occipitalis* (Lacertilia), and *Coronetta iheringii*.

EMBRYOLOGY.¹

ON THE AVAILABILITY OF EMBRYOLOGICAL CHARACTERS IN THE CLASSIFICATION OF THE CHORDATA [*concluded*].—1. The lowest major subdivision of the Endocyemate subphylum embraces forms in which the ovum is invested by a zona radiata, external to which comes an additional investment of albuminous matter secreted by the oviduct, this albuminous envelope being usually in turn covered by a fibrous membrane immediately overlaid by a porous, more or less calcareous shell, also secreted by the oviduct. Chalazæ are often developed. The cleavage is partial, the germinal matter, as a rule, forms but an insignificant part of the whole ovum, and is aggregated at one pole of the latter as a blastodisk. The blastodermic vesicle is developed from the blastodisk by epiboly upon the vitelline mass, which is finally included so as to occupy a ventral position in the vesicle. Development is at most viviparous only during the very earliest stages or while the ovum is passing through the oviducts, or more or less entirely oviparous, or quite ovoviparous. The allantois is greatly developed, but never associated in the development of a true placenta, though it is usually respiratory in function.

Under this definition the three following groups seem to be appropriately included:

a. Ova buried in the earth or sand by the parent, and left to be incubated by the heat of the sun. Some species ovoviviparous. Reptilia.

b. Ova incubated by the parent in a nest specially constructed for the purpose. Aves.

c. Ova incubated by parent in an abdominal marsupium or in a nest at the end of a burrow. Recently hatched young nourished by the parent for a time upon milk secreted by mammary glands. No functional uterus. Ornithodelphia.

It may also be noted that with group *b* the distinctly warm-blooded series of the Chordata begins. The relatively high temperature of the body of the adult plays an important part in incubation or in accelerating metabolism in the embryo. The preceding three groups, on account of the many features of resemblance and reptilian traits possessed in common (group *c* being apparently affiliated with the extinct Theromorpha of Cope), might be considered to form a series to be called Paratheria.

12. The highest major subdivision of the Endocyemate sub-

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phylum embraces the eutherian type, or the viviparous Mammalia, in which the ovum is invested only by a zona radiata. The ovum also becomes more or less covered over by reflections of the uterine epithelium, or processes from the surface of the ovum are received into furrows or pits of the mucous surface of the uterine cavity, in which embryonic development proceeds more or less nearly to completion, and where the developing embryo acquires nourishment after the manner of a parasitic organism. The cleavage of the egg is total, and leads to the formation of a hollow, rapidly-enlarging, blastodermic vesicle or blastula, in which no vitelline matter or deutoplasm lies free in the ventral pole or yolk sack. This group is characterized by its viviparity, the development of a placenta and the possession of a functional uterus; it has obviously descended from one of the preceding groups which had ova provided with a large yolk, the yolk having gradually atrophied or failed to develop as the peculiar viviparous mode of development became more and more pronounced.

a. The lowest division of the Eutheria would be separated from the highest, on embryological grounds, by the circumstance that the vascular system of the foetus is brought into relation with the maternal vessels by means of the vessels of the yolk sack (Owen, Osborn). Or by means of pseudopodal processes of the cells forming the yolk sack, *Phascolarctos* (Caldwell). Allantois more or less rudimentary. *Didelphia*.

b. In the highest division of the Eutheria the vascular system of the foetus is brought into relation with the maternal vessels by means of the allantois, which is concerned in forming a villous or spongy vascular mass known as the placenta. *Monodelphia*.

In the present state of our knowledge it seems premature to attempt a definition of the orders of the *Monodelphia* upon the basis of placental characters alone, as the following scheme seems to show. It is difficult, however, not to believe that the non-deciduate and diffuse type of placenta is the most primitive, and that then follows the deciduate zonary, and finally as the most specialized the deciduate discoidal. This seems to me must have been the order of evolution of the forms of the placenta, for the reason that in the *Paratherian*, *Endocyemate* form, from which the Eutheria have undoubtedly been developed, the vascular allantois invests the whole embryo. In this succession the orders of the *Monodelphia* will therefore be here arranged as nearly as possible:

aa. Placenta non-deciduate, diffuse or cotyledonary. *Cetacea*, *Sirenia*, *Ungulata*.

bb. Placenta non-deciduate, diffuse (*Manis*); or non-deciduate ? nearly zonary (*Orycteropus*); or non-deciduate, zonary (*Dasypus novemcinctus*); or deciduate discoidal (*Dasypus* sp., *Cholæpus*). *Edentata*.

cc. Placenta deciduate, zonary. *Carnivora*, *Proboscidea*, *Hyracoidea*.

dd. Placenta deciduate, discoidal or exceptionally non-deciduate and diffuse as in the Lemuridæ. Rodentia, Insectivora, Cheiroptera, Primates.

Much remains to be learned of the earliest stages of the formation of the placenta, especially in the Primates. In *Talpa*, Heape has found a rudimentary "träger" or suspensor developed. In some of the Rodentia the embryonic mass is precociously invaginated into the blastocœl, and the amniotic cavity is formed in the most extraordinary manner, or by a sort of vacuolization or accumulation of fluid (liquor amnii) in the midst of the mass of undifferentiated embryonic cells. This occurs in *Mus*, *Arvicola* and *Cavia*, according to Selenka. In these forms the blastodermic vesicle also becomes adherent to the uterine epithelium at a very early stage, and the suspensor is very markedly developed in the three forms mentioned. The precocious invagination of the undifferentiated embryonic mass of cells into the blastocœl leads, in the Rodentia, to an apparent inversion of the embryonic layers. These forms have therefore attained the most specialized mode of development known amongst Mammalia, so that, judged by the standard of embryology alone, they would rank higher than the Primates.

The foregoing scheme illustrates in a very striking manner the way in which complication after complication has been added to the developing germ, starting with a simple blastula developed by total cleavage in *Branchiostoma*; the next step in the progress of embryonic specialization is that seen in the amphibian and marsipobranchian embryo, in which a distinct neurenteric canal is also developed, and in which the neurenteron is continued into the enteric cavity, which itself traverses the segmented vitelline mass longitudinally along its upper half. In the next grade of specialization, or that represented by the Ichthyes of this arrangement, the vitellus remains unsegmented for a long time, and is practically excluded from sharing in the formation of the enteric walls, but the embryo is sessile in the greater number of species embraced in this series, and while only a portion of the blastodermic area leads to the differentiation of an embryo, no part of the ectoblast is ever so folded off to form provisional organs such as the amnion and false amnion, which serve only a temporary purpose, to be finally cast off when they have subserved their function in the development of the embryo, as in the highest forms. These latter, or the endocyemate types, as a rule, develop a blastoderm with a relatively very large area, but only a very small portion of the ectoblast ever takes a permanent share in the formation of the body of the embryo, the remainder of this layer being entirely deciduous. In the Paratherian series of endocyemate types, viz., Reptilia, Aves and Ornithodelphia, there is a large yolk developed, which seems to have determined the development of the hollow yolkless blastosphere of the Eutheria, in which, how-

ever, there is a manifest tendency for that structure to increase rapidly in size owing to the imbibition of fluid with which the blastocœl becomes more and more distended, this increase in size at the same time being aided by the division of the cells entering into the formation of the walls of the blastocœl. The greater part of the walls of this vesicle are finally metamorphosed by a process of folding off and ingrowth of the embryo into the vesicle by invagination, into a respiratory apparatus and secondary system of envelopes, a portion of which also takes part more or less extensively in the absorption of pabulum from the surrounding uterine surfaces which may be more or less completely reflected around the embryo and its vesicle, to be finally cast off at birth together with those parts of the vesicle derived from the ectoblast, which are also deciduous. The vesicle also tends, with a few exceptions, to thrust out hollow villi, which dip into pits in the uterine mucosa. These may arise locally or all over the vesicle, and reach their fullest development when the chorion has been formed, when the greater part of the surface of the vesicle acquires a shaggy covering of villi, into which vascular loops from the allantois are insinuated, over a restricted area internally or over its whole surface. These then become more or less completely insinuated into vascular uterine crypts into the constitution of which a decidua may or may not enter.

It will, I think, be obvious to any one, that if an oviparous paratherian form were to have the eggs which it produces so modified as to lose the shell, yolk and albuminous and fibrous envelopes, leaving only the naked endocyemate ovum to be retained near the outlet of the oviduct, the wall of which would then become thickened so as to form a specialized uterine dilatation, the conditions for a realization of the eutherian mode of viviparous development would be present. In this way, no doubt, the peculiarly specialized mode of mammalian development arose.

Objections may be urged against the position I have assigned to the Amphibia and Marsipobranchii as well as to the names given to the groups, and to the stress laid upon the physiological aspects of development and their importance not only in taxonomy but also in tracing the mode of the evolution of particular grades of development.

The form of the placenta seems to depend upon several factors : (1) The early or late attachment of the blastodermic vesicle to the uterine walls ; (2) the early or late invagination of the embryo or embryonic mass ; (3) the extent of subzonal membrane covered by the allantois, and the mode in which the latter is extended ; (4) the form of the uterine cavity in which the blastodermic vesicle is lodged, whether tubular, bicorned or irregular ; (5) the position and disposition of the uterine mucosa which is brought into relation with the placenta, whether it lines the conical or tubular

cornua, sides or fundus of the uterus ; (6) the disposition of the crypts, fossæ, pits or folds of the uterine mucosa ; (7) the arrangement and disposition of uterine vessels from which the maternal tufts or villi are fed and derived. These influences are largely mechanical in character, and like the influence exerted by the vitellus, lead, in certain cases, to very remarkable modifications of embryonic development.

The foregoing scheme deals more especially with the evolution of the various higher types of development, and if the way in which these have grown out of the lower ones has been made a little less obscure than hitherto, my object in writing this will have been attained. The manner in which placentation has been modified is also a fruitful subject for farther investigation, not less so, in fact, than the question as to how the amnion arose. The facts of embryology tend to show that the amnion is the result, as stated above, of the gradual invagination of the embryo into the blastodermic vesicle. The invagination begins at the head end of the embryo ; the amnion, as is well known, always developing its first traces at the cephalic end of the embryonic disk. It is also probable that the cavity of the false amnion is the homologue of the cleavage cavity of certain of the lower forms.—*John A. Ryder.*

PHYSIOLOGY.¹

A CONTRIBUTION TO THE KNOWLEDGE OF PEPSIN².—Sundberg has hit upon a method for preparing pepsin, which gives results better than those obtained by Brücke's method.

Calves' stomachs are taken, the pyloric portion removed and the remainder of the mucous membrane carefully washed with water. The superficial portion of the membrane is then scraped off with a watch glass, and the substance thus obtained is ground up with a weighed quantity of salt. Enough water is added to this to make a saturated solution of salt. After standing 24–72 hours this was filtered and the Na Cl removed by dialysis. The dialysed liquid contained very little albumin and had a very powerful peptic action. It was further purified by being kept at 40° C. for some time to destroy the rennet ferment, and was then allowed to digest itself for one or two weeks, until all the albumin was converted into peptone. To this liquid chloride of calcium and acid sodium phosphate were added, and the liquid made weakly alkaline by ammonia ; the resulting precipitate of calcium phosphate carried down the pepsin with it. The precipitate was collected in a filter, thoroughly washed with water and dissolved in as small a quantity as possible of five per cent HCl. This solution was then thoroughly dialysed. The liquor obtained finally, when brought to the proper degree of acidity, digested very ac-

¹ This department is edited by Professor HENRY SEWALL, of Ann Arbor, Mich.

² Zeitsch. f. physiol. Chemis. 9, 319. Sundberg.